

Infrared Wake-Up Circuit

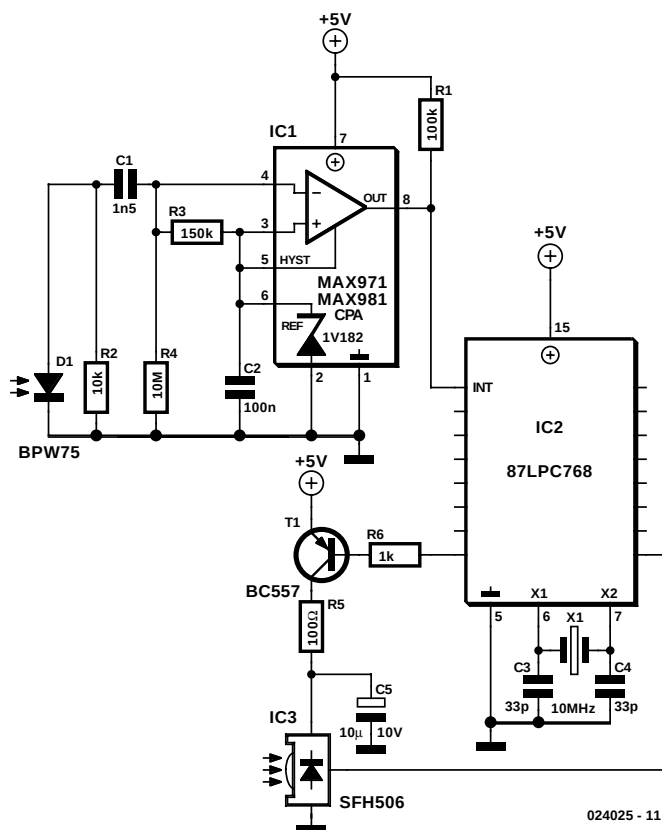


For all battery-operated devices, regardless of whether they use disposable or rechargeable batteries, the lower the current consumption is, the longer the operating time of the device. For this reason, all functions not needed at the moment are switched off if possible and only switched on when needed or by the user. Any circuit containing a receiver used for remote control or communications is faced with the problem of current consumption if the circuitry always has to be active. For instance, the current consumption of typical photosensor module fitted as an infrared receiver in entertainment electronics equipment is around 1–2 mA, which defeats economical battery operation. It is thus necessary to find a way to circumvent this inconvenience without noticeably affecting the user.

Using the supplementary circuit described here, the photosensor module that is actually responsible for controlling the device is only activated when infrared light (originating from a remote control unit, for example) strikes a second photodiode. This photodiode is followed by an especially low-power comparator, whose operating current of around 4 μA represents an insignificant load to the battery and which generates a switching signal when the photoelectric current exceeds a particular value. Due to the absence of an amplifier stage, the wake-up circuit is naturally not very sensitive. Depending to the type of photodiode used, the range extends to approximately 50 cm.

The circuit is built around a Maxim MAX971 IC (<http://pdf.serv.maxim-ic.com/arpdf/MAX971-MAX984.pdf>), which contains a reference voltage source in addition a comparator and is particularly suitable for battery-operated equipment, due to its typical current consumption of 2.5 μA (4 μA max.). The MAX971 is a member of a whole family of low-power comparators (see Table).

The photoelectric current of photodiode D1, which is operated as a photoelectric generator, produces a voltage across resistor R2. This voltage is capacitively coupled to the comparator input. This mode of operation was chosen because the current consumption is significantly lower than if the diode is operated as a photodetector with a bias voltage. The reference voltage U_{ref} and voltage divider R3/R4 provide a



voltage of around 18 mV to the comparator inputs. Thanks to the built-in reference, this voltage is independent of the supply voltage. A high-pass filter formed by C1, R3 and R4 eliminates low-frequency interference, such as 50-Hz mains hum. The voltage across C1 consists of U_{ref} less the bias voltage of 18 mV. Any voltage generated by the photoelectric current through R2 adds to the voltage across C1. Consequently, any infrared signal that exceeds the threshold level of 18 mV across R2 causes the comparator output to switch to Low. Due to the input offset voltage, the IR triggering threshold varies over a range of approximately 6–28 mV. R1 acts as the load resistor for the open-drain output of the comparator and can be omitted if the following microcontroller has an internal pull-up resistor.

Type	Internal reference	Number of Comparators	Internal hysteresis	Package
MAX971	1 %	1	yes	8-pin DIP/SO/ μMAX
MAX972	none	2	no	8-pin DIP/SO/ μMAX
MAX973	1 %	2	yes	8-pin DIP/SO/ μMAX
MAX974	1 %	4	no	16-pin DIP/SO
MAX981	2 %	1	yes	8-pin DIP/SO/ μMAX
MAX982	2 %	2	yes	8-pin DIP/SO/ μMAX
MAX983	2 %	2	yes	8-pin DIP/SO/ μMAX
MAX984	2 %	4	no	16-pin DIP/SO

In order to reduce the current consumption to a minimum, the microcontroller (IC2) is put into the Sleep mode by the application software when there is nothing for it to do. This causes the oscillator to be switched off, which ‘freezes’ all of the activities of the IC. With a Philips 87LPC768 microcontroller, for example, the current consumption drops from a typical level of 15 mA at a 10-MHz clock frequency to typically 1 μ A. A High–Low edge on the INT pin triggers an interrupt that causes the oscillator to automatically resume operation, so the software continues to run from the location where it stopped on entering the Sleep mode. After the supply voltage for IC3 is switched on, the output of the photosensor module is checked for the presence and activity of a coded sequence of signal

level changes. If this is not seen, it can be assumed that there was some sort of noise and the microcontroller again ceases its activities. The transistor can be omitted if the associated output can supply enough current for IC3.

The photosensor module IC3 is naturally only needed if it is necessary to receive and decode a carrier-based infrared signal, for example using RC5 coding and a 36-kHz carrier frequency. If the limited range is sufficient for the intended use, the microcontroller can also directly process a signal sent in Flash mode that is present at the comparator input. With such a signal, the information content is represented by the times between successive light flashes.